The test results of superconducting DC and AC cables in Russia.

Victor **SYTNIKOV**, Sergey **BEMERT**, Maxim **ROMASHOV**, Victor **KARPOV,** Igor **KRIVETSKIY,**
Timofei **RYABIN;** R&D Center @ FGC UES, Moscow, Russia
vsytnikov@gmail.com, bemert_se@ntc-power.ru, romashov_ma@ntc-power.ru, Karpov_VN@ntc-power.ru
Krivetskiy_IV@ntc-power.ru, ryabin@ntc-power.ru

ABSTRACT

Superconducting cables have evident benefits when transmitting large power flows through electrical networks in comparison with traditional ones. The Russian R&D program for superconducting HTS power devices includes the creation of HTS AC and DC cable lines. Two cable lines on the transmitted power of 50 MVA/MW were produced and tested in the framework of the program. The critical cables dependence upon temperature for both cables was measured. All cables underwent high voltage test successfully. Current leads and joints have been developed and tested in wide range of currents and voltages. Detailed test results will be shown in the paper.

KEYWORDS

Superconducting cable, design, critical current, test.

INTRODUCTION

The efficiency of electricity generation and its transportation to the consumer are becoming the priorities in the development of power industry in the XXI century. Simultaneously, requirements for environmental and resource-saving parameters in all phases of production and distribution of electricity are increasing. Meeting the growing demands is only possible by using the most progressive and advanced technologies, including superconductivity. These problems are appearing in megalopolises most acutely.

The load growth in metropolitan power systems makes it necessary to put into operation new generating and network equipment. At the same time in order to improve the reliability of consumer power supply the reservation of substations is implemented (new transmission lines are built and brought into service) that occurs in multiple connection network creation, so called multi-ring network. These trends contribute to higher levels of short circuit currents in power systems. To reduce the levels of short circuit currents to safe values, current-limiting reactors and network sectioning are used. However current-limiting reactor application occurs in additional power losses and network sectioning occurs in the reduction of consumer power supply reliability. Moreover network development (based on XLPE cables) increases the complexity of power flow controllability and may lead to transmission lines over current. HTS DC cable line commissioning (instead of XLPE cables with current-limiting reactors) is delivered from these drawbacks. When using HTS DC cable line, a new quality of transmission system is acquired. Cable line becomes an active controlled element of the network that is capable of power flow regulation and fault current limitation.

HTS LINKS BETWEEN SUBSTATIONS IN METROPOLITAN AREAS

Power energy system of megalopolises is a dynamically developing structure, which has the following features:

- rapid growth of energy consumption that, in general, exceeds the increase of consumption throughout the country;
- high density of energy consumption;
- areas' deficiency and branching of distribution networks;
- partitioning the urban area electrical network to reduce short-circuit currents.

All these factors ultimately determine the main problems in power grids of metropolitan areas, namely:

- a high level of power losses in distribution networks;
- high levels of short-circuit currents that in some cases exceed the breaking capacity;
- low level of controllability.

On the other hand, the loading of substations in the city is very uneven. In many cases, substation transformers loaded only on 40- 60 %. As a rule, the input substations in the cities feed from separate high voltage feeders. The connection of substations on the side of the medium voltage would ensure mutual redundancy of power network sectors, release backup transformer capacity that will ultimately lead to reduction of energy losses in the network. In addition, this type of connections, allow release capacity to connect additional load without additional transformers or new substations and power transmission lines [1, 2, 3]. Fig.1, reproduced from [1], illustrates the concept.

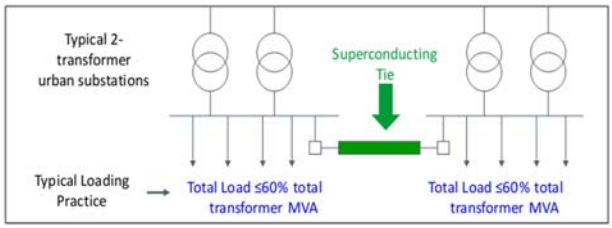

Fig.1: Substation interconnection concept

However, the direct connection of substations will lead to a substantial increase in short circuit current. There are three superconducting cable projects purposed to connect two substations without short-circuit currents increasing.

- Project HYDRA, New York, USA [1, 4].
  The project purpose is installations of HTS AC cable system in New York City that would provide a high capacity link (96 MVA) on the secondary side of the transformers in two nearby urban substations. The cable system would have an inherent ability to limit fault current magnitude by using 2G conductors that are specially designed to quickly transition from the superconducting state to the resistive state, thereby providing a low impedance current path during nominal operating conditions and a high impedance path during over current conditions.